

SPATIAL VARIABILITY OF COTTON FIBER PROPERTIES

R.M. Johnson

Texas Tech

Lubbock, TX

J.M. Bradow

USDA, ARS

New Orleans, LA

P.J. Bauer and E.J. Sadler

USDA, ARS

Florence, SC

Abstract

The economic survival of U.S. cotton producers will be determined by how rapidly and successfully improved cotton production technologies and cost efficiencies can be developed and adopted. Precision Agriculture [PA] is an information- and technology-based agricultural system that identifies, analyzes, and manages site spatial and temporal variability within fields for optimum profitability, sustainability, and protection of the environment [Robert et al., 1995; 1996].

Only recently have PA systems shown potential for use in cotton production [Smith, 1996; Wilkerson and Hart, 1996]. The PA approach to cotton production is an engineered system in which cultural inputs are made on a 'need basis' in a site-specific system that micro-manages spatial and temporal variability through mapping and integration of soil and plant data [Smith, 1996]. It is the objective of this research to map soil variability in relation to both cotton fiber yield *and* quality in a field under commercial production.

Cotton was grown in a producer's field in Florence, SC. Soil and fiber were sampled from a grid and several transects in an attempt to represent the natural field variation. Soil properties determined included soil moisture, organic matter, pH, Ca, Mg, K, P, and Na. Fiber quality was estimated by

HVI and AFIS, and fiber strength was determined by the stelometer method. All data were analyzed by both conventional statistics and geostatistical techniques [variogram analysis and kriging]. Both soil and fiber properties proved to be variable in the field investigated. Soil moisture, pH, P and organic matter appeared to have the greatest influence on both cotton quality and yield.

Soils data from both grid and transect samples were highly variable with all soil properties exhibiting non-normal distributions. For the grid samples, the coefficient of variation ranged from a low of 9.1% for soil pH to a high of 73.6% for soil phosphorus. Transect data were also variable with soil pH exhibiting the lowest coefficient of variation [CV = 2.7%] and soil calcium the highest [CV = 44.2%]. The significant ranges in the values of the measured soil properties suggest that this field might benefit from site-specific management techniques.

Cotton yield and fiber quality data also exhibited significant variability, although less than for the soil properties. The highest variability was seen in cotton yield [CV = 52.3% for the grid] and a range of 0 to 4.23 bales. The coefficients of variation ranged from 34 to 150.1% for the four transects with a range in yield from 0 to 3.17 bales. The fiber properties that exhibited the highest variability in the grid samples were Fine Fiber Fraction and Immature Fiber Fraction [CV = 20.1% and 14.8%, respectively]. Other properties that showed noticeable variability included Short Fiber Content by Weight, micronAFIS, and micronaire. [Ten percent of the samples were in the micronaire penalty range.] All of these properties have been demonstrated to have a significant environmental link. The fiber from the transect samples exhibited similar trends in fiber properties with Fine Fiber Fraction, Immature Fiber Fraction, Short Fiber Content by Weight, micronAFIS, and micronaire having the highest variability.

Soil and fiber maps provided an easily visualized picture of 'in-field' variability. The lowest yield was observed in the southern section of the field. This part of the field is in a 'Carolina Bay' and is typified by a higher moisture content and flooding during periods of high rainfall. The southern section of the field also exhibited elevated soil organic matter and soil phosphorus levels and lower soil pH values. Soil Cation Exchange Capacity [CEC] was also variable with two distinct bands in the southern and mid-section of the field having increased CEC. This increased CEC is probably related to increases in soil organic matter and clay content.

Elevated levels of Immature Fiber and Fine Fiber Fractions were observed in several areas of the field and were most notable in the southeast section of the Carolina Bay. As previously stated, this part of the field was also characterized by low soil pH. In those areas where high Fine Fiber and Immature Fiber Fractions were observed, areas of low fiber circularity, micronAFIS, micronaire, strength, and diameter were also observed. All of these properties are indices of fiber maturity and possess a strong environmental link.

Although a significant correlation was observed between micronaire and micronAFIS, differences were noted in the field maps. These differences were probably caused by a sample-size discrimination [i.e., HVI requires a >50 g sample, compared to the AFIS requirement for a 1 to 5 g sample]. Because several plots yields less than 50 grams, HVI analysis was not performed on those samples. All plots received AFIS analysis due to the smaller sample-size requirement.

This research has demonstrated that sufficient spatial variability exists in cotton fiber quality to merit implementation of site-specific management techniques. These PA technologies will offer the grower new opportunities for measuring and managing the variability in soil and fiber properties. This, in turn, will help to increase production efficiency while minimizing adverse environmental impact and maximizing profitability.

References

- Robert, P.C., Rust, R.H., and W.E. Larson. (Eds.) 1995. Site-Specific Management of Agricultural Systems. Amer. Soc. Agron., Madison, WI. 993 pages.
- Robert, P.C., Rust, R.H., and W.E. Larson. (Eds.) 1996. Precision Agriculture. Amer. Soc. Agron., Madison, WI. 1222 pages.
- Smith, W.F. 1996. Precision farming overview. Proceedings Beltwide Cotton Conferences. 179-180.
- Wilkerson, J.B., and W.E. Hart. Yield sensing technology in cotton harvesting applications. 1996. Proceedings Beltwide Cotton Conferences. 184-186.